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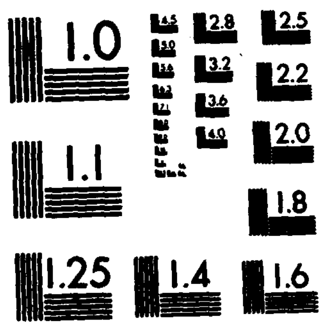

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EMPTAC USER'S GUIDE

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April 1988

Final Report

Approved for public release; distribution unlimited.

AIR FORCE WEAPONS LABORATORY
Air Force Systems Command
Kirtland Air Force Base, NM 87117-6008

This final report was prepared by the Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico under Job Order 37630151. Lieutenant Dale R. Cleaveland (NTAA) was the Laboratory Project Officer-in-Charge.

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This document covers major areas of interest which a user must consider when planning an EMPTAC test. It attempts to familiarize potential user's with AFWL policies and procedures governing the use of facilities and resources. A general description of the EMPTAC, EMP facilities, and resources that can be made available to the user is also provided.

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1.0 INTRODUCTION

1.1 PURPOSE

This guide was established to give test managers a way to familiarize themselves with the Air Force Weapons Laboratory's ~~(AFWL)~~ electromagnetic pulse (EMP) test aircraft ~~(EMPTAC)~~ program located at Kirtland Air Force Base (KAFB), New Mexico. Brief descriptions of the available EMP test facilities at KAFB are also included. This guide should give prospective customers (users) adequate information to scope the magnitude of their test effort and to accomplish general planning without extensive involvement in test execution details. (Keywords; hardened volumes; shielded cables; Modular Data System; Hardness Surveillance Illuminator).

1.2 OBJECTIVES

The objectives of this document are to:

- Point out major areas of interest which a user must consider while planning an EMPTAC test (Section 1.4)
- Familiarize the user with AFWL policies and procedures governing the use of facilities and resources (Section 3)
- Provide a general description of the EMPTAC, EMP facilities, and resources that can be made available to the user.

1.3 GENERAL

1.3.1 EMPTAC Program Description

1.3.1.1 Background. The EMPTAC program was initiated to solve specific technical deficiencies by providing a dedicated aircraft (A/C) for demonstrating/validating electromagnetic pulse (EMP) hardening concepts and improving EMP assessment techniques. Prior to the EMPTAC program, specific hardening techniques used on A/C had to be evaluated in conjunction with system level EMP tests on operational A/C. This made the evaluation of specific hardening methods secondary to the overall assessment of the system's EMP hardness. Therefore, because of the strict system level test

schedules, adequate time to investigate state-of-the-art hardening technology and hardness assessment techniques did not exist. So, to avoid problems associated with performing tests on operational A/C (availability, test scheduling, configuration control, and air worthiness requirements), AFWL procured the EMPTAC, a dedicated test-bed aircraft.

The EMPTAC program allows efforts to be integrated and focused on realistic needs. This program begins to bridge the gap between the research and development (R&D) and the operational communities. It provides a vehicle to demonstrate and correlate the theoretical studies and laboratory experiments in a system level environment.

1.3.1.2 Objectives of the EMPTAC Program.

- The specific objectives of the EMPTAC program are to demonstrate and evaluate the feasibility of particular hardening concepts, assist in further development of prototype designs and military specifications/standards, and to improve EMP hardness verification/assessment methodologies. An additional objective is to assure that protection requirements specified for electromagnetic interference and natural atmospheric lightning are complemented and integrated with EMP protection requirements.

- The EMP test aircraft program is designed to carry on previous contractual and in-house research efforts managed by AFWL. Those efforts have provided most of the theoretical bases for current EMP hardening, EMP simulator development, and EMP hardening verification efforts. This program improves test capabilities and is the demonstration of developed EMP hardening technology. It includes program planning, reconfiguration of the aircraft to perform its various test-bed requirements, testing and documenting the EMP response of the unhardened EMPTAC (baseline characterization), and testing, which will develop and assess hardening technologies and hardness monitoring techniques, improve hardness assessment techniques, and develop hardness surveillance/maintenance technology.

1.3.2. Support Facilities

Adjacent to the EMPTAC, on the TRESTLE hard-stand, are seven 12 ft by 50 ft trailer slots. These slots have the necessary potable water, sewer, and electrical hookups. Telephone lines are available but must be requested

through the 1960th Information Systems Squadron on KAFB early in the test planning stages. Specific trailer arrangements must be made by the user during test planning and coordination meetings. At the other facilities, trailers can be made available provided requirements are known early.

1.3.3 Support Vehicles

AFWL and KAFB have a variety of special purpose vehicles available (e.g., forklifts, aircraft tugs, and trucks). In addition to the vehicles, there are also several pieces of nonpowered aerospace ground equipment (AGE) such as maintenance stands and a dielectric access stand which are readily available. Users must identify their needs and negotiate during early planning and coordination meetings so that any necessary special arrangements can be made for their use.

1.3.4 Experimental Support

1.3.4.1 EMP Test Design. AFWL can provide technical consultation and test planning assistance in the planning stages of an EMP test. Once the requirement for an EMP test is established, the test objectives must be clearly and concisely stated. Then, if possible, a set of experiments and data requirements must be defined to meet those objectives. Also, the early establishment of pass/fail criteria should be made. AFWL support can range from technical consultation which includes assistance in developing test objectives, acceptable experiments, test plans, statements of work, and program plans to complete test planning. AFWL is directed by Air Force Program Management Directive to provide EMP test support to users within the limits of available resources.

1.3.4.2 Data Acquisition, Processing, and Analysis. The primary reason for performing an EMP test is to gather data. The rate at which quality data can be acquired depends on many variables and is the prime consideration in determining the facility schedule. Because of these variables, the user should have detailed discussions with AFWL to determine data acquisition rates and the time available for the data acquisition phase. These

data, once acquired, can be processed on-site, within 24 h, in most cases. Then data can be analyzed using available resources, such as the EMPTAC Vax 11-750 computer, discussed in the next section.

1.3.5 Computer/Analytical Support

The EMPTAC Program has the following Computer/Analytical capabilities available to support organizations that are using/supporting the EMPTAC Program:

Computers: One Digital Equipment Corporation (DEC) VAX 11-750 minicomputer. Two Zenith Z-158 microcomputers.

Vax Terminals: One Tektronix 4010 with hardcopy capability. One Visual 550.

Note: In addition to these dedicated terminals, the Z-158 microcomputers are also configured to act as terminals to the VAX 11-750. In addition to the software for the VAX/Z-158s, the EMPTAC Program can provide the following analytical capabilities:

- ATDAS - EMP test data processing and analysis system with the capability to process and analyze test data acquired by Techtronix 7912 digitizers and to analyze test data acquired by LeCroy digitizers that have been preprocessed by the AFWL LeCroy Data Processing System (LDPS). Time-tying of data records is provided by this system. In addition to the processing of EMP test data, ATDAS provides a variety of general signal processing and analysis capabilities.

- LDPS - This data processing system was designed specifically to process the test data acquired by LeCroy digitizers and to provide the capability to analyze the data. This system is discussed in depth in Section 1.6.6.

- SIG - SIG is a general purpose signal processing and analysis system developed by Lawrence Livermore Laboratories. Section 1.6.7 has more information on this system.

- SLEET - SLEET is a data base/information management system designed for the storage, archiving, retrieval, reporting, and correlation of EMP test data. Further discussion of SLEET is found in Section 1.6.8.

There are four dial-up phone lines available to the EMPTAC VAX to provide remote access capability. Classified processing (up to Secret) of data is available on an as-needed basis. Programming support can be provided, as required, but this is limited to the access and use of the VAX/Zenith systems and software. Code development support is negotiated as part of a formal EMPTAC Program support request. Hardcopy output is provided for the VAX, TEK 4010, and Zenith systems with Hewlett Packard (HP) plotter support.

1.4 TEST PLANNING CONSIDERATIONS

1.4.1 General

This section provides the user with the basic information necessary to scope the contemplated test effort and to produce a milestone schedule of events. It will concentrate on baseline planning efforts and timing of events rather than on the details of test execution. These considerations will also help the user to prepare for the general and detailed test planning necessary for an efficient, thorough test effort.

1.4.2 Importance of Good Test Planning

As with any project, the importance of sufficient planning cannot be over emphasized. The sole purpose for testing is to gather enough quality data to support some predefined test objectives. These data are used after testing is complete to try and answer the questions which originally generated that particular test program. Therefore, data acquisition becomes the most important part of the overall test, but can be the easiest to accomplish provided adequate planning has been done. Conversely, poor or inadequate planning can result in many difficulties such as delays, poor data, excessive data, insufficient data, or even good data taken at the wrong test points. Once testing is complete, it is no longer a simple matter to salvage the test. Poor data cannot be changed into good data and recovery is not nearly as easy as in the pretest, planning phase. The entire results of the program are then questionable at best. Poor planning can also result in downtime and, considering that data acquisition costs are approximately $8,000 to $10,000 per day, can result in additional funding requirements or

even termination of the test activities. Consequently, poor planning generally results in a program that doesn't accomplish its goals and often results in cost overruns.

1.4.3 Requirements

The first step in designing an EMP test is to define the test requirements. The test requirements should be based on the overall program requirements, time and funds available, and on past efforts (tests, analyses, and studies). The test requirements should serve as the justification for undertaking the test effort and should explain why a test is the most economical and efficient method for acquiring the needed information.

1.4.4 Objectives

After the test requirements have been determined, the specific objective(s) of the test should be defined. The objectives should be stated very narrowly and very precisely to avoid losing sight of the requirements. The objectives must be based on and be consistent with the requirements. AFWL is available to assist in determining if desired objectives are achievable with current capabilities. Once the objectives are defined, all planned efforts must pass three criteria. They must (1) contribute toward attaining the objective(s), (2) satisfy the requirements, and (3) provide a clearly traceable audit trail relating objectives to results. Pursuing efforts that do not fill these criteria result in a waste of resources.

1.4.5 Milestone Schedule

After determining your objectives, you must begin timing of the test. Determining when certain items must be given to AFWL is a very important part of planning a good test. Set up date (with AFWL) for completion of items such as test plans, safety plans, etc. Once you've established the milestones for the test accomplishment, establish a schedule that can be followed through to test completion. The user is encouraged to submit his inputs to AFWL as far in advance of the scheduled dates as possible.

1.4.6 Funding

The final stage in the user's overall planning is to estimate the level of funding that must be provided to AFWL. The user should expect to fund the preparation, the operation, and the posttest activities of the EMPTAC and any facilities which are to be involved in the testing. Due to the many variables involved, funding should be discussed in depth with AFWL prior to requesting and committing to a specific funding level for the effort.

1.5 EMPTAC Aircraft Functional Description

1.5.1 General

The EMP test aircraft is a commercial Boeing 720B A/C which was flown for a number of years by Israel's El Al Airlines and was then converted from passenger to cargo service. It was acquired from the commercial market by the United States Air Force (USAF) in August of 1984 after having flown in excess of 58,000 h and making over 20,000 takeoffs and landings. Designed and manufactured by the Boeing Airplane Company in 1962, this aircraft is in the 210,000 lb-plus gross weight class. The EMPTAC is being kept in a nonflying, operational mode. Its four turbofan engines are used to supply electrical power, pressurization, and air conditioning if required. The JP-4 fuel to run the engines is stored in six integral wing tanks and a center wing tank. These tanks require special attention, i.e., inerting when the aircraft is to be exposed to electromagnetic (EM) pulsing. The aircraft possesses a standard suite of commercial avionics with very high frequency (VHF) and high frequency (HF) radios, VHF navigation, an air traffic control (ATC) transponder, doppler navigation system, marker beacon, ADFs (automatic direction finder), weather radar system, autopilot and flight director system. Principal aircraft dimensions are shown in Fig. 1. For more detailed information on the 720B aircraft support and avionics systems, refer to the Boeing Commerical Maintenance Manuals, Document No. D6-8012, Chapters 6 through 79. The aircraft has forward and aft baggage areas located beneath the main cargo floor. The fiberglass wall panels, all insulation, and miscellaneous fixtures have been removed from these bays, as well as from the

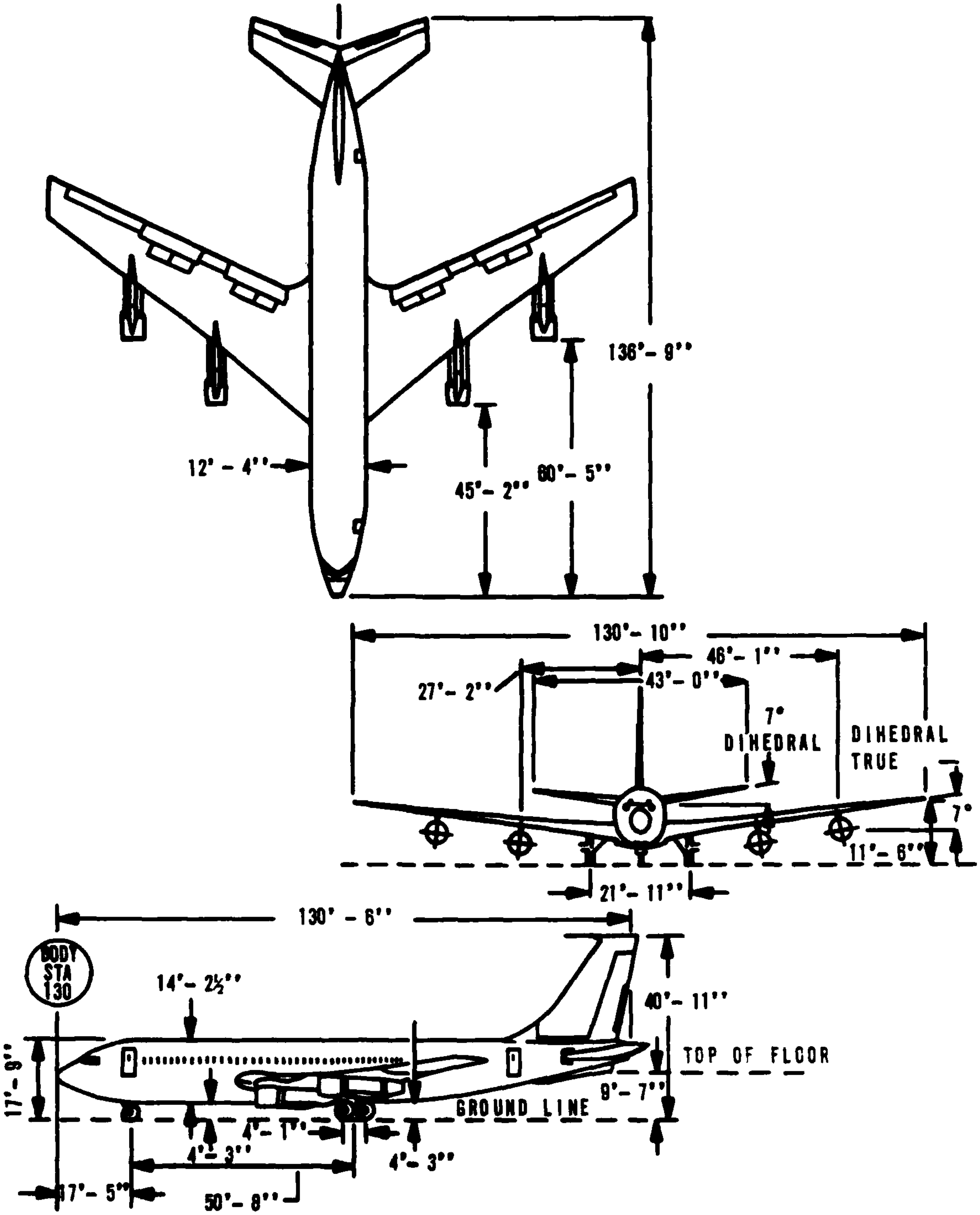


Figure 1. Overall principal aircraft dimensions.

main cargo area, to allow easy access to the underlying aircraft systems and to the aircraft skin. Both baggage compartments and the area from Station 960 to Station 1440 in the main cargo area have been specially treated to form hardened volumes (see Section 1.5.2). The EMPTAC is normally located at the TRESTLE hardstand on KAFB. This area is convenient to the Gibson, Wyoming and Truman gates. As the TRESTLE is a restricted area, access must be obtained through EMPTAC personnel. See Section 2.1 for more information on the TRESTLE. The hardstand location is near most of the test facilities and provides required controlled environmental support. There are electrical power, conditioned air, and gaseous nitrogen (for inerting) supply hookups located on the hardstand.

1.5.2. EMP Hardened Volumes

In order to make the EMPTAC more representative of hull hardened aircraft and those with shielded bays, three volumes within the EMPTAC were hardened (Fig. 2). These are the forward and aft baggage compartment areas and the area from Station 960 to 1440 in the main cargo compartment. The physical dimensions of the two main shielded areas (1) aft main cargo and aft baggage compartment, and (2) forward lower baggage compartment, are shown in Figs. 3 and 4. The size of these compartments within EMPTAC is of interest to enable the user to determine how much space there is to work in and where the points of entry into these volumes are located. The hardened areas contain many hardening fixes including dielectric isolation devices (DIDs), twin conductive pulleys, alpha braided wire bundles, shielded connectors, etc. There are also two simulated B-1B A/C access doors on the left side of the aircraft.

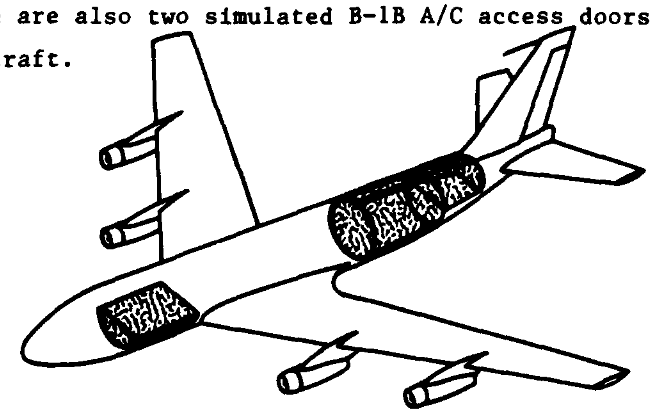


Figure 2. Location of hardened bays.

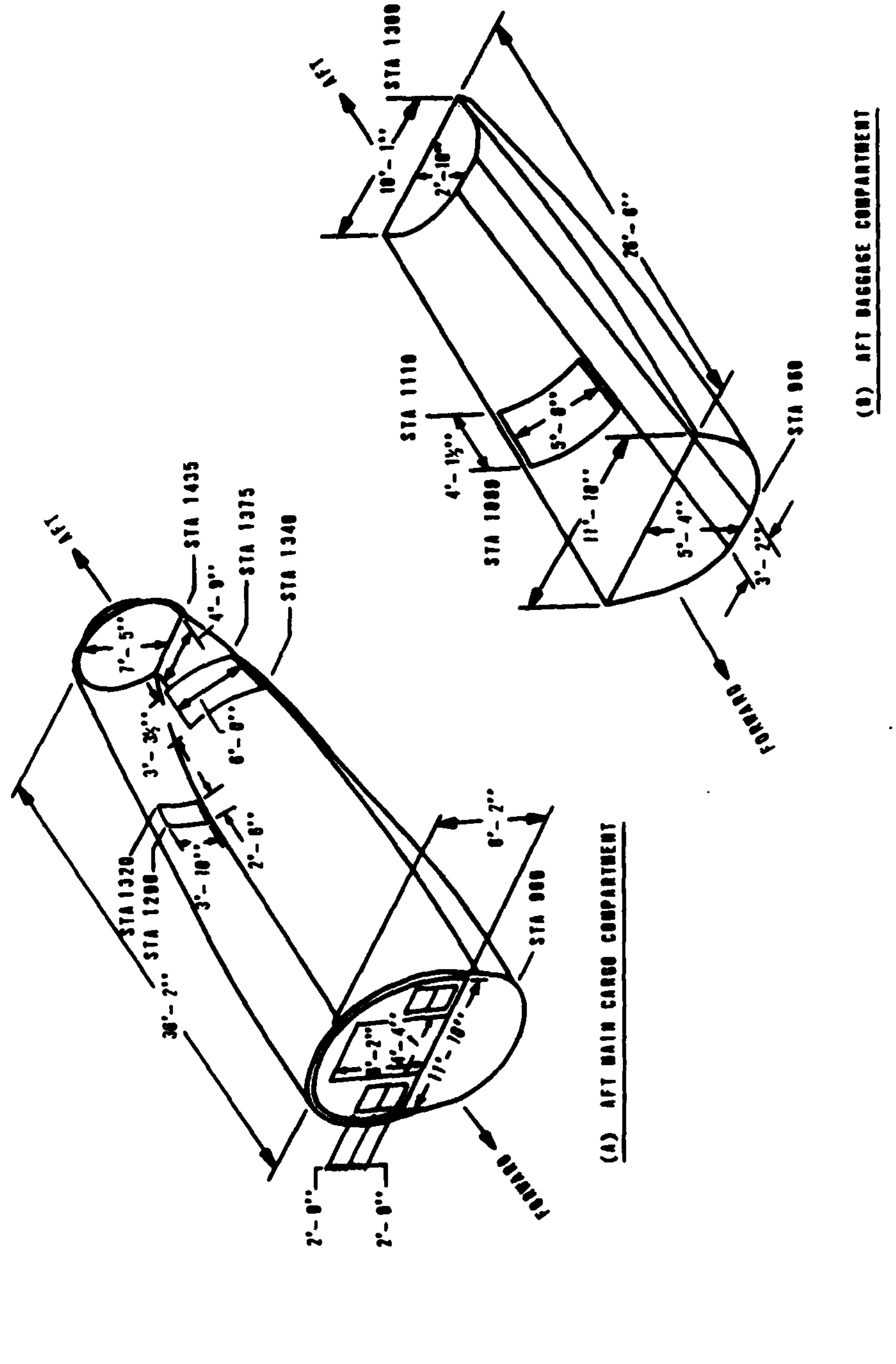


Figure 3. Aft main cargo and aft baggage compartment dimensions.

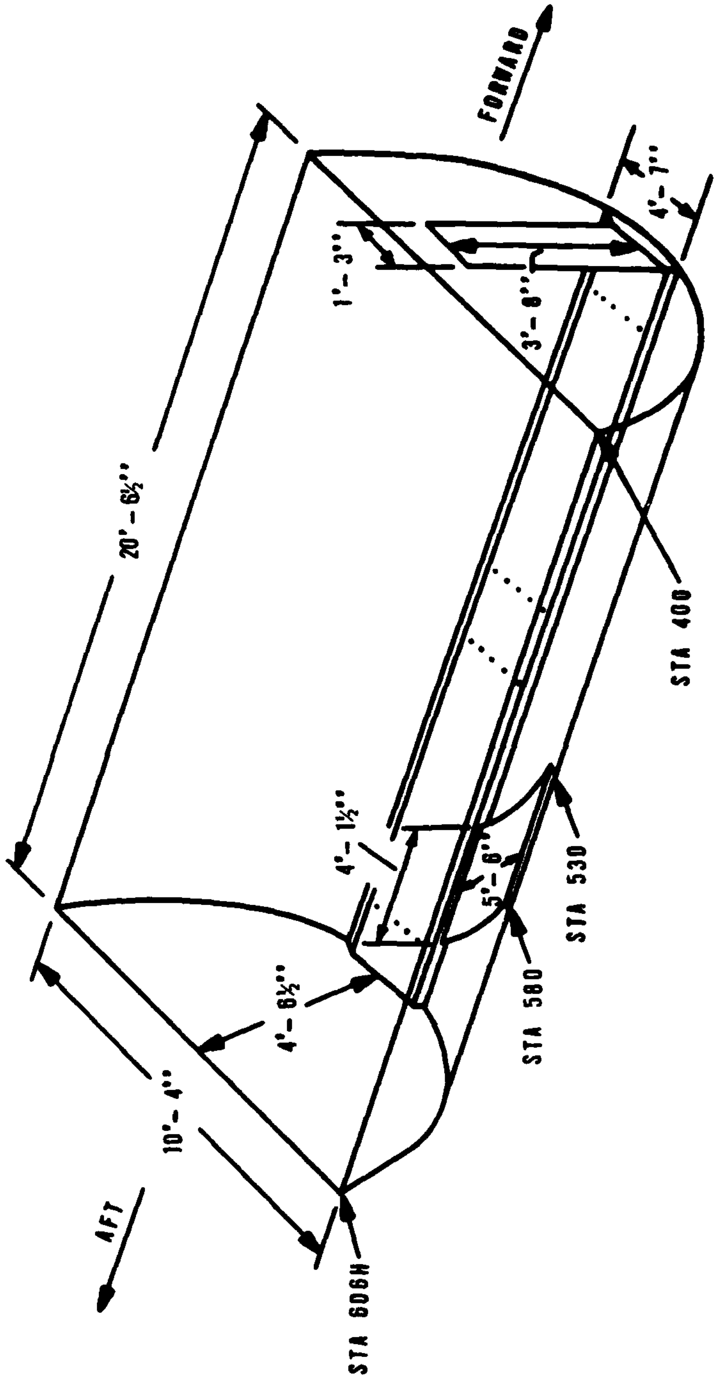


Figure 4. Forward baggage compartment dimensions.

1.5.3 Available Power

The primary electrical system onboard the EMPTAC is 3-phase, 400 Hz, 115/200 VAC. Power can be generated by the four 30-kVA generators driven by the aircraft engines through constant speed drives. There is also an auxiliary power system (APS) mounted in the left wheel well. This APS is a diesel powered generator which can be controlled from a panel at the flight engineer's station. In addition to the onboard power systems, the EMPTAC can also use power supplied from conventional ground power units and from the power supply located at the TRESTLE hardstand.

For a more detailed description, see the "EMPTAC Experiment Configuration Modification (#1) Final Report" (Ref. 2).

1.6 RELATED EMPTAC PROGRAMS AND DEVELOPED SYSTEMS

1.6.1 Hardness Surveillance Integrated System

AFWL is currently developing a mobile data acquisition trailer capable of testing aircraft for hardness surveillance (HS). The hardness surveillance integrated system (HSIS) will be a self-contained system which can be set up at the aircraft's home base to check nuclear hardness. The purpose of HSIS is to measure how effectively hardening components minimize stress and maintain their hardening integrity. HSIS will also be used to determine if a degradation has occurred, where the degradation is located, and how significant the degradation is. HSIS will have two methods for testing hardness surveillance, direct injection and continuous-wave (CW) illumination.

1.6.1.1 Direct Injection. In the HSIS, two 2 kW linear power amplifiers will be used to simulate an EMP environment by injecting high current into a test object. The purpose is to determine the strength factors of the hardening device. The measured test data will be transmitted to the data acquisition system for archiving and further analysis. See Section 2.4 for more information on direct drive capabilities.

1.6.1.2 Continuous Wave Illumination. HSIS will also have a CW electromagnetic source which will produce a well characterized incident field to radiate the test object. The test probes will measure the aircraft responses and transmit the data to HSIS. The HSIS CW data acquisition system will be comprised of three separate systems: (1) illumination system, (d) data acquisition system, and (3) data analysis system.

- Illumination System. The illumination system for the CW system will produce low-level CW electromagnetic energy. This energy will have a well characterized incident pattern field that approximates a transverse electromagnetic (TEM) plane wave over a wide range of frequencies (100 kHz to 100 MHz). The hardness surveillance illuminator is discussed further in Section 2.2.

- Data Acquisition. The data acquisition system will contain the instrumentation package (such as test probes, fiber optic links, network analyzers, computers, etc.) needed to make measurements for nuclear hardness integrity. This system will gather data, apply the correction factors to account for instrumentation, and store data for on-site and future analysis. A general configuration for the instrumentation is shown in Fig. 5. The data system is centered around the HP-A900 computer/controller and the HP-3577 network analyzer. The computer will control all data acquisition and record all instrument settings in the data header. The network analyzer will supply the radio frequency signal to the power amplifier. The power amplifier output will drive the HS illuminator. The network analyzer will also record measured CW data. The CW data will consist of three signals: Reference (R) and two test signals (A, B). The reference signal is a free-field signal which indicates the incident field characteristic measured through the reference channel on the network analyzer. The test signals are measured responses of the aircraft. These signals are transmitted via fiber optic links to the network analyzer. The network analyzer data are then recorded on a hard disk for future analysis.

- Data Analysis. HSIS will have two A900 computers. One computer will be used for controlling data acquisition. The second computer will be used to do on-line data analysis, archiving, etc. An in-house AFWL data analysis software package is being developed to analyze the CW data. Existing routines such as point of entry (POE) induced response (PIR) processing, single and multiple file processing, and matrix norms are being updated. New analysis routines such as threat extrapolation, B-1B (A/C) scalar norms, and modal analysis are under development. The HSIS will also utilize the modular data system (MDS). This will allow technicians to set up 80 test points. See Section 1.6.2 for more details.

If a user desires to move his test object to a high-level transient pulser, the HSIS can be used as a data acquisition van for

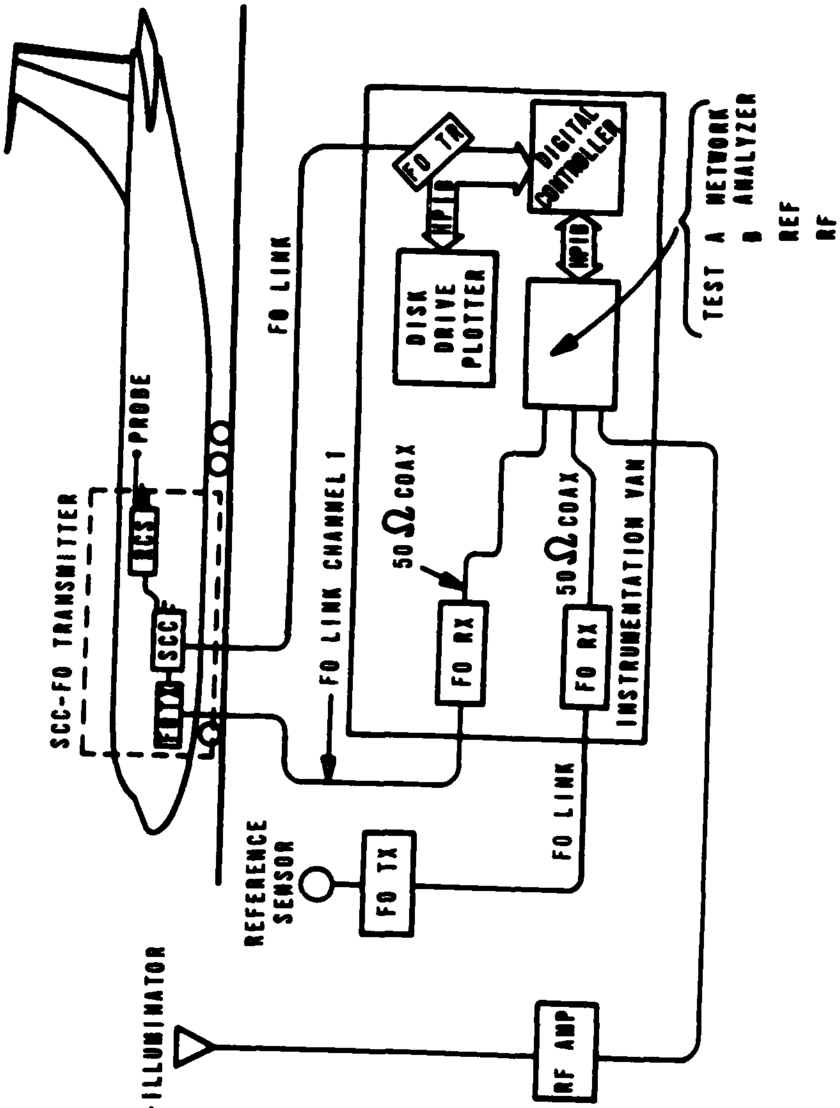


Figure 5. Single-channel CW data acquisition system.

collecting data without changing any instrumentation. Overall, HSIS will provide the user a flexible, portable and cost-effective means to evaluate nuclear hardness. Further information on the HSIS and MDS can be obtained from AFWL/NTAAT.

1.6.2 Modular Data System

The Modular Data System (MDS) is a laser-based data acquisition system used for recording transient and continuous-wave response data. The system is divided into two major components, the artery link transmitter (ALT) and the artery link receiver (ALR). The ALT is used to monitor the aircraft responses from several locations on-board the aircraft. It consists of a signal conditioner, remote coaxial switches, fiber optic transmitters for analog data, and a bidirectional fiber optic digital controller. The data are acquired and transmitted via fiber optic link to the instrumentation van. The ALR is responsible for controlling amplifiers, attenuators, filters, and the laser on the ALT. It also monitors all internal functions such as temperature and flux readings from the laser, battery voltage, and digital communication from the ALT. The test responses are processed through the signal conditioners of the ALT and routed to the ALR. From the ALR, the signal is placed into a ten channel matrix switch and finally recorded on LeCroy digitizers or HP-3577 network analyzers. The MDS package will operate inside the computer automated measurement and control (CAMAC) crate and respond to the CAMAC command structure. The signal to noise ratio is 40 dB with a noise figure of 5 dB at a bandwidth of 200 MHz. The frequency response is DC to 400 MHz (typical). The MDS system has ten channels, eight for data acquisition and two for spares. This system provides for advance instrumentation of up to 80 test points to save time during testing.

1.6.3 Shielded Enclosures

Two shielded enclosures were built to be used in experimental studies of shielding effectiveness. These enclosures (Fig. 6) measure 4' x 5' x 6'. One of the enclosures is single-walled and one is double-walled. They each have three plain sides and three sides with 2' x 2' removable interchangeable

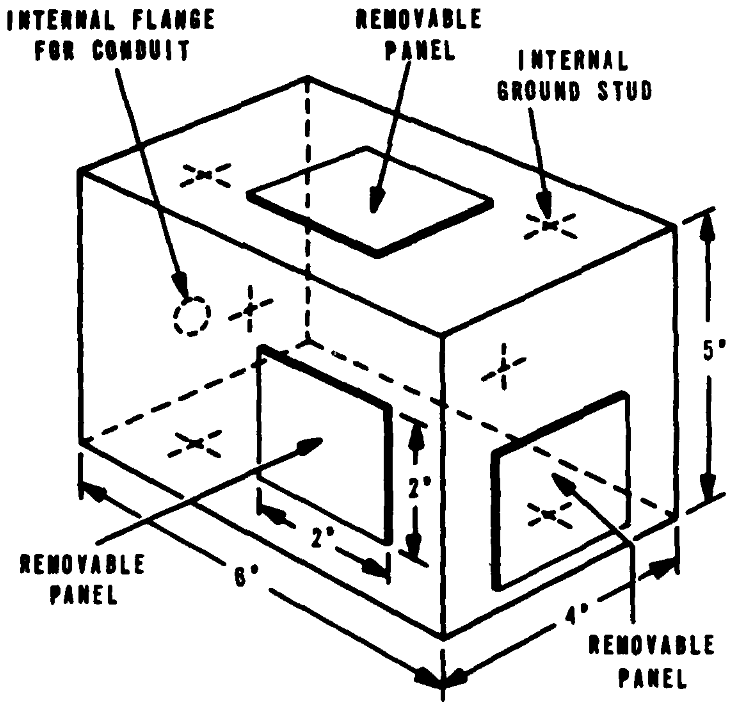


Figure 6. Replaceable panels with generic aperture penetrations.

panels. The double-walled enclosure allows testing of multilayered materials. The replaceable panels (Fig. 7) allow testing of a large variety of different types and arrangements of line and aperture penetrations, and composites. These panels can also be interchanged with those at flight station 960 on the EMPTAC. The enclosures can be excited using portable radiators, direct current injection, and plane waves in free space. This research has applications in HS testing, in testing the HSIS, and in hardening element testing.

The main objective of this research is to develop a new shielding effectiveness standard to encompass testing for EMP and other EM environments. Another objective is to evaluate and document the applicability of EMP hardening treatments for aperture and line penetrations. The EMPTAC implements hardening elements such as twin conductive pulleys and dielectric insertion devices (DIDs) in the design of the hardened volumes on the aircraft. The

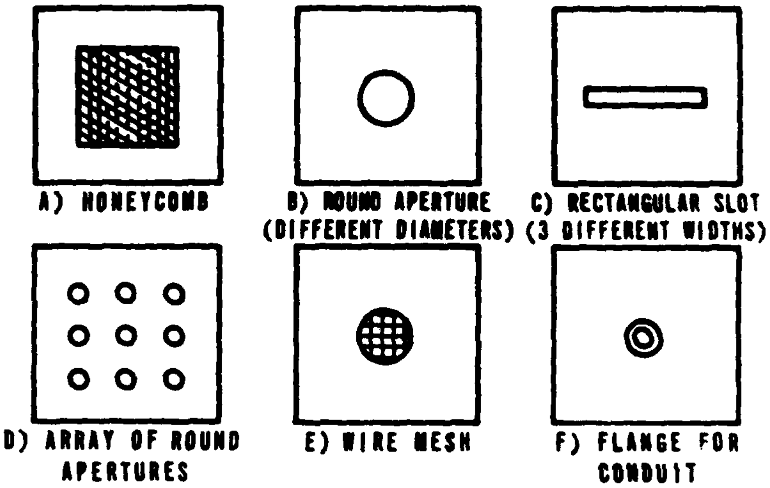


Figure 7. Replaceable panels with generic aperture penetrations.

baseline performance characteristics of these hardening elements was determined using the shielded enclosures. When the hardening degradation kit is developed, the characteristics of degraded hardening elements will also be determined.

Other objectives include developing EMP test assessment methodology for heavily shielded systems such as the B-1B A/C, evaluating theoretical and experimental stress bounding techniques for use in system EMP assessments, and determining the shielding characteristics of composites. One feature of the enclosures is that one or both of them can be put into the aft shielded volume on the EMPTAC if a two-layered topological system is needed for testing.

The shielded enclosure research is being conducted in Building 911 at KAFB. The initial lab setup and box characterization have been completed. Testing began in February 1985 to develop I-wire/I-bulk relationships and to support the EMPTAC cable shield tester effort. Testing has also been done on the EMPTAC hardening elements.

1.6.4 Shielded Cable Tester

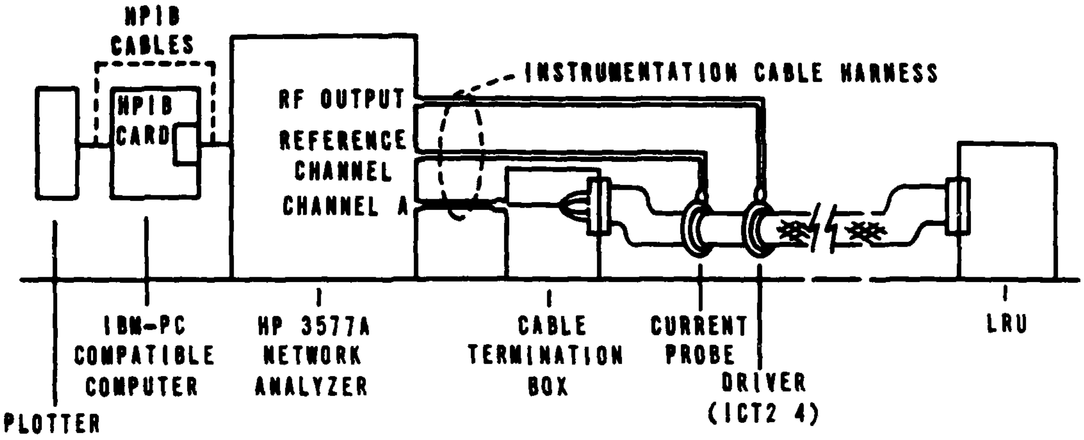
A tester to determine degradations in shielded cables is being developed under contract to AFWL. The technology to construct a tester which will determine if the shield of a cable is intact has been successfully demonstrated and a prototype tester is now being developed. This tester was specifically designed to address the problem of verifying cable shield integrity on EMP hardened aircraft, but can be used on other shielded cable applications.

Typical degradations, such as dirty or loose connectors, improperly bonded backshells, and apertures in the cable braid can all be detected, identified, and located without removal of the entire cable from the aircraft using this tester. Its ease-of-use makes it suitable for use at an Air Logistics Center (ALC) depot. The test set-up (Fig. 8) and data interpretation (Fig. 9) are very basic and would be appropriate for a 5-level (journeyman) technician to perform. Development of a prototype tester was completed in October 1986.

1.6.5 Hardening Element Degradation Kit

A hardening element degradation kit has been developed at AFWL. This kit contains various degraded counterparts for most of the hardening elements in use on the EMPTAC. The kit can be used to degrade the shielding effectiveness of the hardened volumes on the EMPTAC to determine the capabilities of various hardness testers. The degradations are, to the greatest extent possible, blind degradations. That is, they are not identifiable as degradations without some sort of test being performed.

The kit contains several shielded cable faults of different types of severities, degraded filter components, several types of nonlinear devices which have been degraded, and various faulted mechanical penetration devices (i.e., conductive pulleys and DIDs. The kit was designed specifically for the EMPTAC and is not intended to be used elsewhere.



*NOTE: CONSISTS OF 3 (THREE) RG223 COAX CABLES WITH TYPE N CONNECTORS (MALE). BOUNDED TOGETHER AS SINGLE HARNESS. CAN BE 2-30 FEET LONG.

Figure 8. Shielded cable tester test setup.

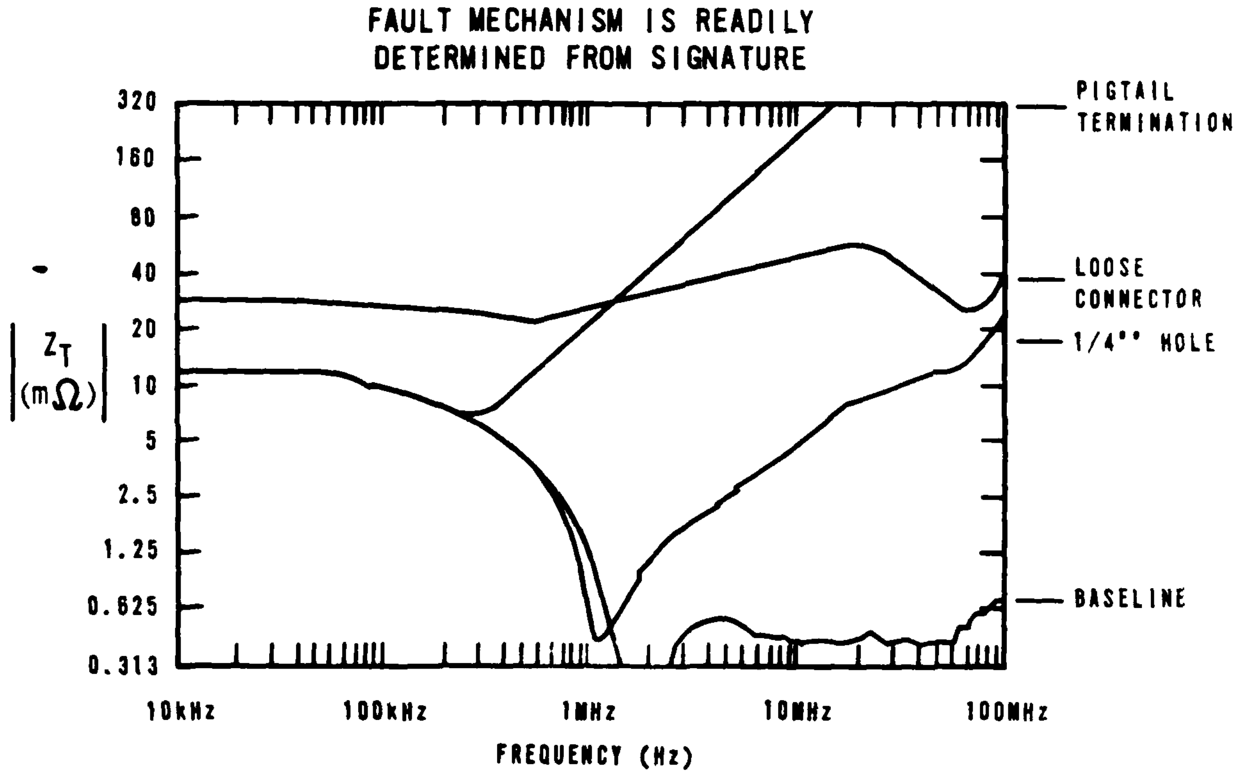


Figure 9. Typical transfer impedance signatures of degradations.

1.6.6 EMPTAC LeCroy Data Processing System (LDPS)

The EMPTAC (LPDS) data processing system was initially developed on the AFWL Cray-1 computer to process the lightning and EMP data acquired by the AFWL/NASA/DNA F-106 EMP/lightning program. This software was transferred to the EMPTAC VAX 11-750 computer for the EMPTAC program, and will be used by the AFWL HS program to support the B-1B A/C EMP HS tests in 1987 and 1988.

The LDPS is an integrated, user-friendly system designed to process raw data waveforms to obtain the best estimate of the sensor response during EMP SIMULATOR TESTING. The LDPS operates interactively and is structured to permit user familiarity with a minimum of special training, using prompt lines and extensive input error checking. LDPS use indicates that comprehensive review, editing and processing of 100 or more raw data records can be accomplished by one person in a single 8-h work day. Improvements are planned as user needs become better defined through experience with the system.

The LDPS accepts raw transient data records obtained from LeCroy flash analog-to-digital (A/D) converter digitizers, containing up to 65,000 points in a single record. Digitizer sampling intervals from 5 to 100 ns may be used. The LDPS will be updated to process data acquired with the new LeCroy 6880 transient recorder (720-ps sampling interval).

The LDPS allows evaluation of the raw data quality and review of the instrumentation chain used to gather the data. In addition, it provides for on-line and hard-copy graphing and analysis of results at each step of the data processing. Features that permit evaluation of the data include: (a) review of the header information included with each data record, (b) review input of scale factors for the instrumentation sensors used for data collection, (c) edit and re-edit of raw data, (d) review instrumentation characteristics, (e) data review and analysis, and (f) provide SIG input files. (See Ref. 4 for more information on the LDPS.)

1.6.7 General Purpose Signal Processing Program

SIG is a general purpose signal processing, analysis, and display program. Its main purpose is to perform manipulations on time- and frequency-domain signals. However, it has been designed to ultimately accommodate other representations for data such as multiplexed signals and complex matrices. The core SIG package contains many of the basic operations that are performed on digitized data. It is possible to build more powerful signal processing algorithms out of these core commands.

Two user interfaces are provided in SIG: (a) a menu mode for the occasional user, and (b) a command mode for more experienced daily users. In both modes, errors are detected as early as possible in the processing and are indicated by friendly, meaningful messages. Other options exist for multiple commands, automatic execution for each item in a repeat sequence, etc.

Many different operations on time and frequency domain signals can be performed by SIG. They include operations on the samples of a signal, such as adding a scalar to each sample; operations on the entire signal, such as digital filtering; and operations on two or more signals, such as adding two signals. Signals, such as a pulse train or a random waveform, may be simulated.

Graphics operations display signals and spectra. When spectra are displayed, the user may select the scaling according to the continuous or discrete domains. Internally, all SIG algorithms scale according to the continuous domain (i.e., multiply by the sample interval).

1.6.8 System Level Evaluation of Electromagnetic Tests (SLEET)

SLEET is an automated data management system developed by AFWL under the EMPTAC Program to provide a repository for EMP test results and test object characterization data. In addition, the SLEET system can be used to analyze, correlate EMP test data and to investigate trends in cable/wire response characteristics. SLEET was developed using data from system level aircraft

EMP tests, but it can also analyze data from other test objects and analyze and correlate data from other types of EM tests (i.e., direct drive and CW).

Some of the major SLEET objectives are:

- Provide an analysis tool for use in developing EMP standards, specifications, and design guidelines.
- Support test planning, including quality control (QC) criteria.
- Provide basis for minimum standardization of both data gathering and handling procedures and data analysis techniques.
- Preserve EMP response data in a systematic, well-defined, easily accessible system.

The SLEET program helps resolve two problems regarding data processing which are applicable not only to the EMP community, but all across the scientific community. First, it provides the ability to go back and reanalyze data from a previous effort and to correlate that data with data from another source taken at another time. Secondly, it stores data requirements in a relational data base management system, once they have been defined, organized, characterized and documented.

2.0 EMP TEST FACILITIES

This section briefly describes the EMP simulation facilities available at KAFB for the EMPTAC testing program operated by AFWL.

The simulators presented here can be considered as either system-level or subsystem-level simulators. System-level simulators are those simulators that will excite the entire, or at least major portions of, the test object or system with an EMP distribution that is nearly the same over the entire system as that produced by nuclear EMP. Subsystem-level simulation is generally through direct injection of appropriate voltage/current into individual electronic boxes. In general, system-level simulators represent two classes of simulation, those which simulate an approximate free-space plane wave on the test system and those which simulate such a plane wave plus the reflections from the surface of the earth.

The relative locations of these facilities at KAFB are shown in Fig. 10. The ability of a particular facility to adequately support a particular test is a complex issue which must be discussed with AFWL personnel early in the planning stages of any test.

Facilities currently available for EMPTAC testing are:

- TRESTLE - provides a horizontally polarized electromagnetic field that can easily accommodate the EMPTAC in various selected flight attitudes.
- Vertically Polarized Dipole II (VPD-II) - provides a large test volume and a vertically polarized electromagnetic environment.
- Horizontally Polarized Dipole (HPD) - provides a horizontally polarized electromagnetic field and has a test volume large enough to accommodate the EMPTAC.
- Mobile Universal Direct Drive Van (MUDD) - provides direct drive capabilities and has its own internal data acquisition instrumentation.

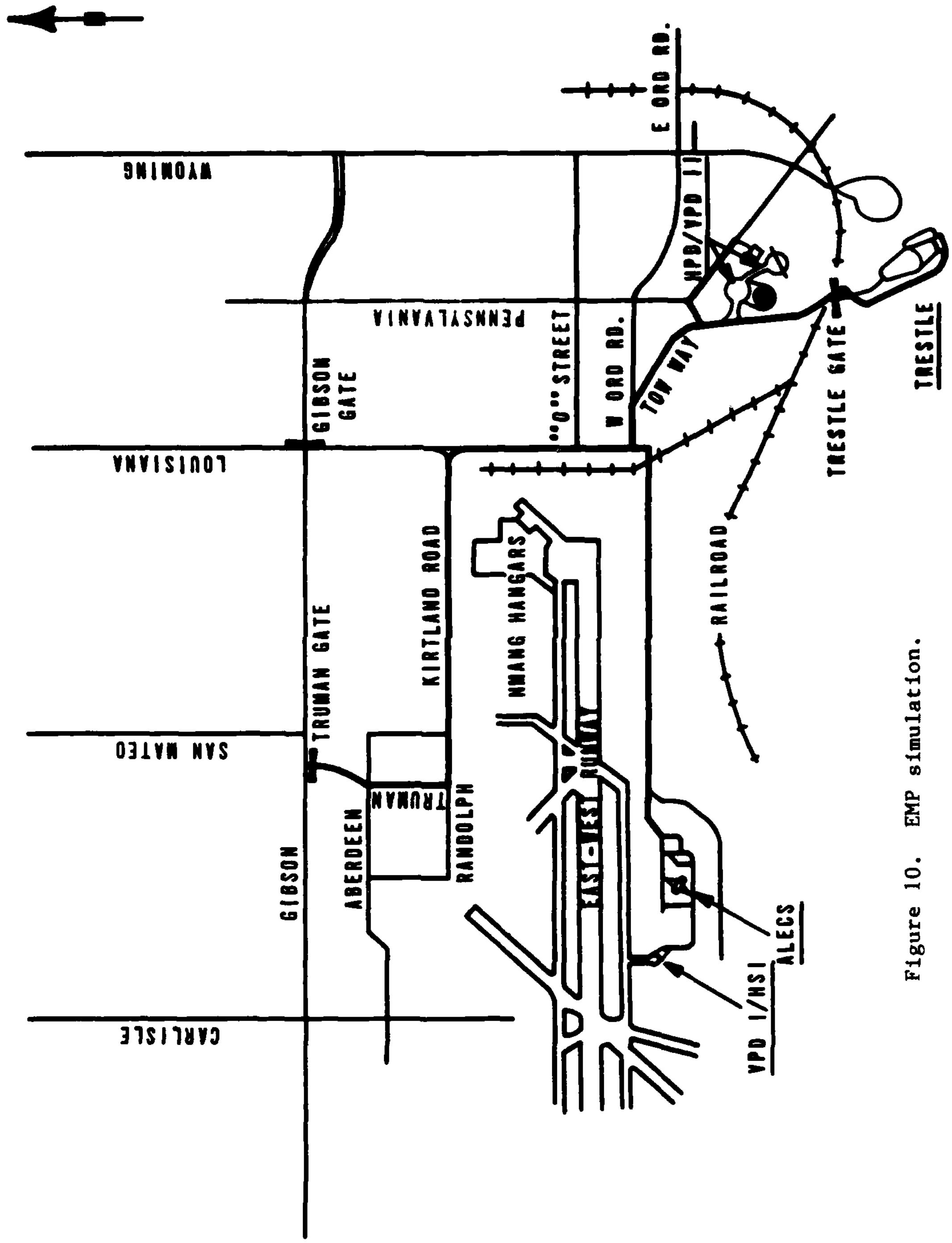


Figure 10. EMP simulation.

Two other facilities which may be available for use are HSI, a guided-wave surveillance illuminator, and the Vertically Polarized Dipole I (VPD-I), which may be reopened.

2.1 MOBILE UNIVERSAL DIRECT DRIVER VAN

AFWL has recently put into operation its newest EMP tester known as "Mobile Universal Direct Driver" (MUDD). It is a trailer mounted system containing signal generators, high power amplifiers, and data acquisition instrumentation. Designed as an R&D tool for maximum experimental flexibility, it is expected that it will serve as a prototype for operational testers which need a subset of its performance capability. Its computer control permits complete operation with as few as two people.

MUDD is housed in a 10' x 50' trailer with special air shock suspension. It can travel over the highway at 55 mi/h without an escort vehicle. A 60-dB screen room houses instrumentation racks and computer equipment. Two air conditioners are slung underneath the trailer to handle the required cooling load in 100 deg weather. The maximum power handling capability is 200 A of 208V, 3-phase, 60-Hz power. However, the actual load depends upon the requirements of the installed equipment and the outside temperature. A halon fire suppression system is built in.

Simulated EMP energy is generated with four damped sinusoidal waveform generators (or, other signal sources can be installed) fed to either one or both of two 4-kW peak power (or 2 kW continuous-wave power) amplifiers. With this arrangement, a wide variety of waveform shapes and power levels can be generated.

Data from the test article are routed to the instrumentation in the screen room by either fiber optics or coaxial cable. Currently, the MUDD is configured to support 18 Tektronix models 7912 and 7612 waveform digitizers as well as an unlimited number of LeCroy 200 megasample/s digitizers and nanofast fiber optic data links. Its designed-in flexibility makes it simple to add virtually any other instrumentation desired, such as network analyzers,

spectrum analyzers, serial and parallel data bus analyzers, LeCroy gigasample/s digitizers, programmable trigger delays, coaxial switches, and other fiber optic systems (analog or digital). The software for computer control of the instrumentation is specifically designed to easily add the software controllers for add-on instrumentation.

MUDD is available to support direct-drive EMP test requirements anywhere in the world. Current plans are to use it extensively for the B-1B EMP Test Program throughout 1987 and 1988. Also, it is a model for development of a similar tester for the Oklahoma City Air Logistics Center in anticipation of hardness surveillance testing of hardened aircraft such as the B-1B.

2.2 GUIDED-WAVE HARDNESS SURVEILLLANCE ILLUMINATOR (HSI)

The guided-wave HSI is a test facility developed at AFWL for use in hardness surveillance/hardness maintenance testing. The development objective was to assemble and demonstrate a simple, two-polarization, continuous wave illuminator system to be used in a hardness surveillance demonstration. The initial demonstration used the EMPTAC as the test object. It will also support a B-1B CW baseline system-level test.

The illuminator is intended to be operated in the CW mode over a frequency range from approximately 100 kHz to 100 MHz. The basic design is a guided-wave transmission line consisting of two wires suspended above the ground. One polarization is generated by exciting the wires in a common mode while the other polarization is produced by a differential mode excitation. The overall dimensions are based upon the assumed test object dimensions, the available site space, and a geometry which produces the most uniform field illumination. The dimensions and the HSI field characteristics are shown in Figs. 11, 12 and 13 respectively.

The location for this facility, as shown in Fig. 13, is the VPD-I site located on KAFB. The guided-wave illuminator will share this location with the renovated VPD-I facility. This location was chosen because of the existing EMP test support facilities available on the site (ground plane,

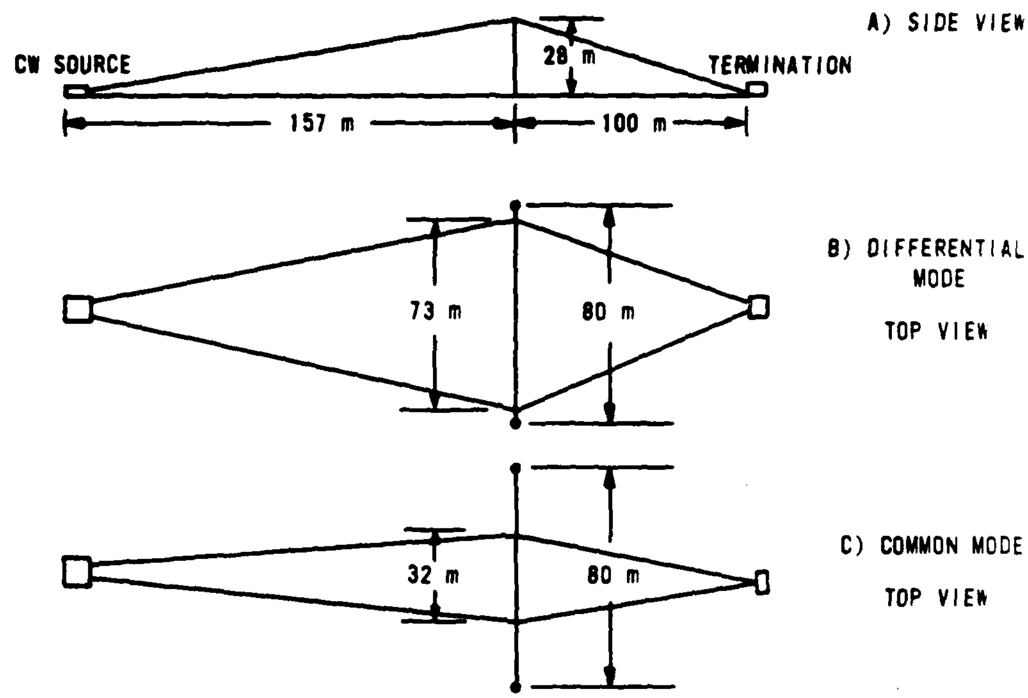


Figure 11. HSI configurations.

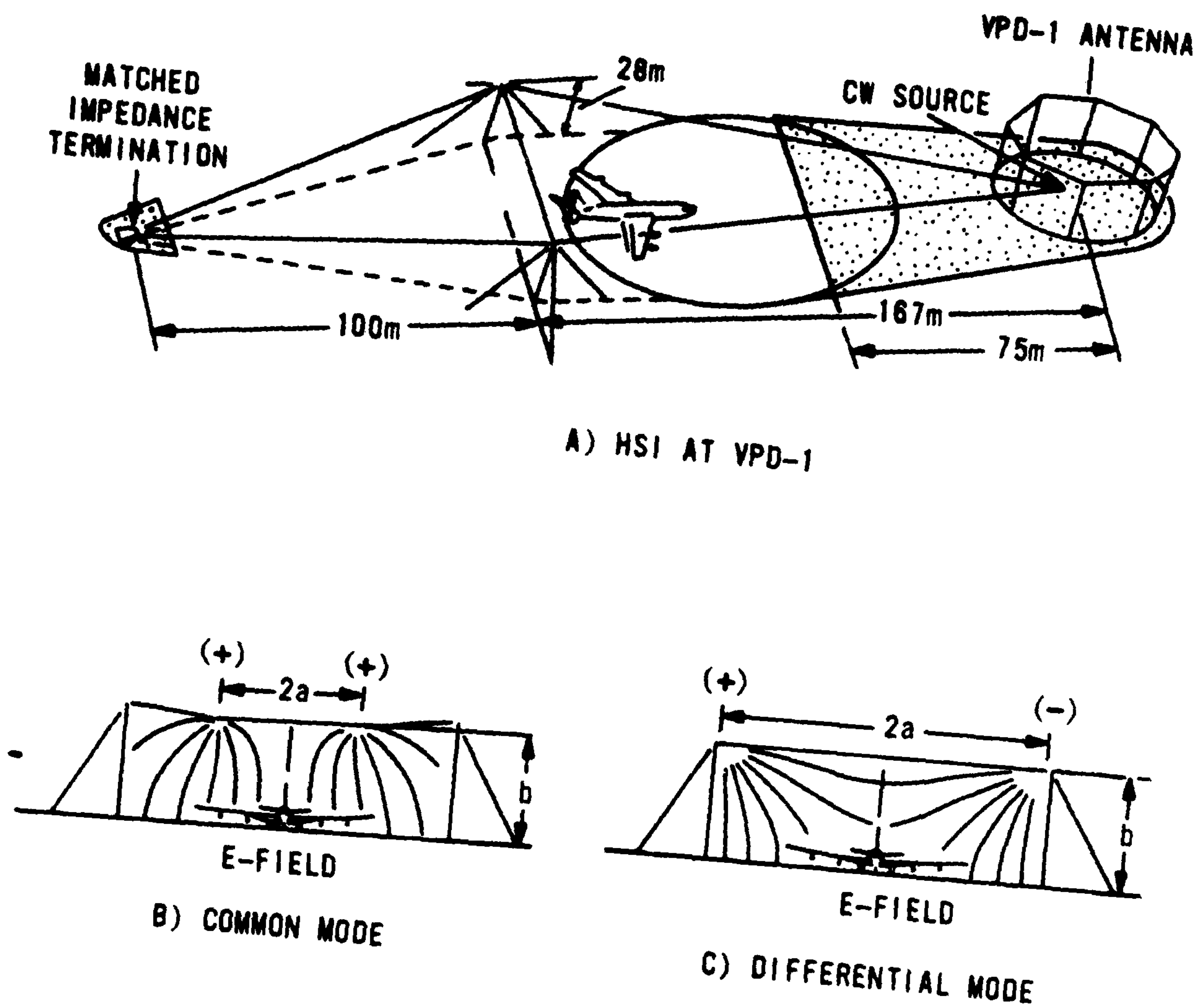


Figure 12. HSI field characteristics.

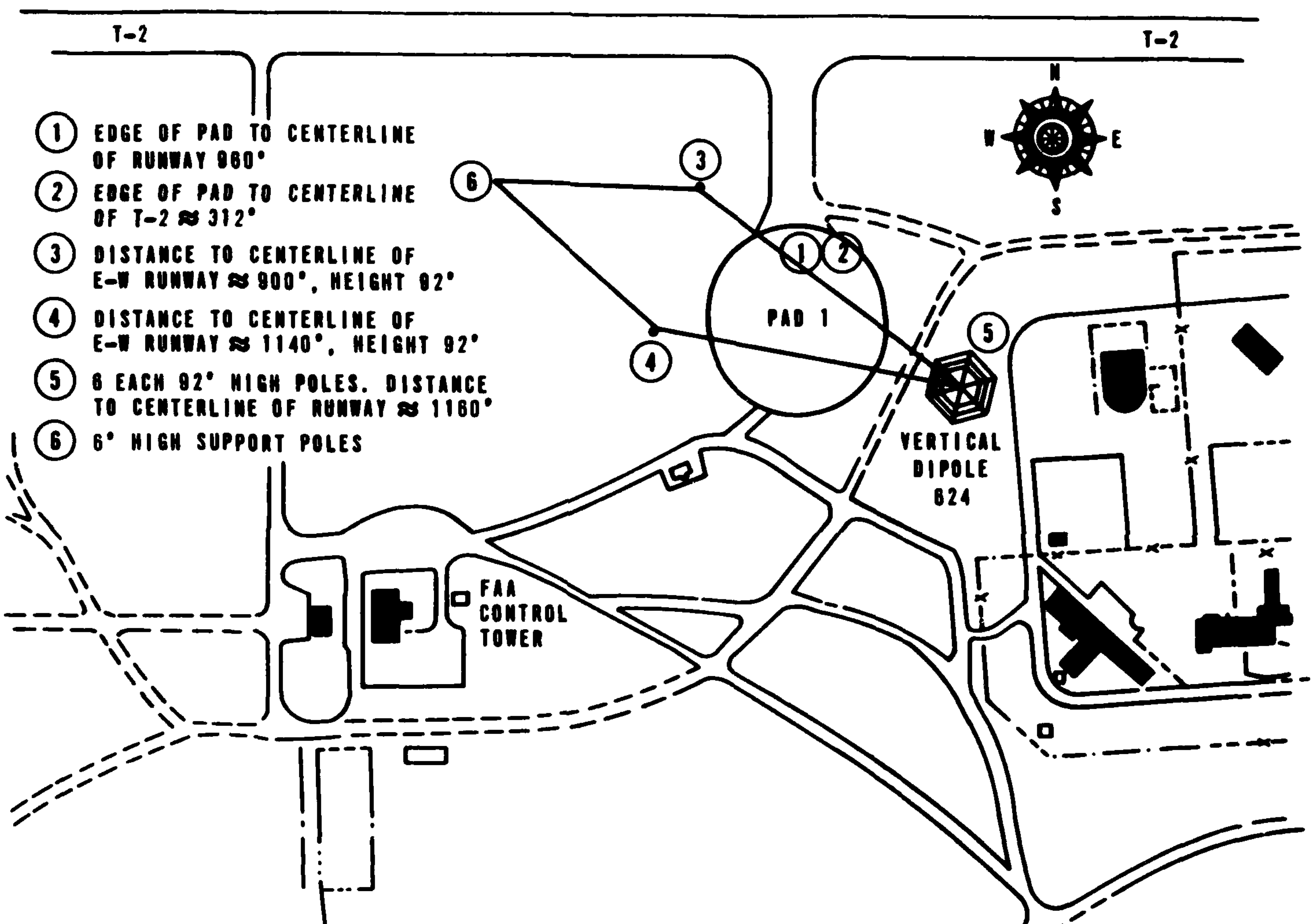


Figure 13. HSI antenna location.

aircraft hardstand, power hookup, reference sensors, and instrumentation conduits). This site will be the proving ground for this type of illuminator. Once its abilities have been demonstrated, it (or one of its successors) will become a part of the deployable HSIS which can be set up at an aircraft's home base to check shielding integrity.

2.3 VERTICALLY POLARIZED DIPOLE I (VPD I)

2.3.1 Description

The AFWL VPD-I facility (Fig. 14) is an electric dipole (vertically radiating) EMP simulator. The simulator uses a ground plane covering the earth as an imaging plane for the vertical monocone antenna. This ground plane extends out to 75 m from the apex of the antenna onto the aircraft parking pad (Fig. 15). The parking pad has been removed beyond that distance to modify the facility to accommodate the HSI antenna. VPD-I is used to simulate the EMP environment which exists outside of the high-altitude nuclear-source region, specifically for test objects located on the earth's surface. As with VPD-II, VPD-I is basically a ground alert mode simulator capable of illuminating very large aircraft.

The VPD-I consists of a 1.25-MV pulser (the HAG-I); a resistively loaded, vertical monocone, radiating antenna; an antenna suspension system; a wire mesh ground plane (located on the surface); an underground instrumentation room; a 91.4-m-diameter test pad; and other support systems.

The circular test pad is 91.4 m in diameter with its center located 100 m from the apex of the monocone. The pad is capable of supporting large aircraft such as the B-52 and E-4. EMPTAC, being smaller than these, poses no problems with size or weight.

2.3.2 Aircraft Considerations

Aircraft can be towed to the VPD-I via a towway which enters the facility from the north. This towway connects to the parallel taxiway which

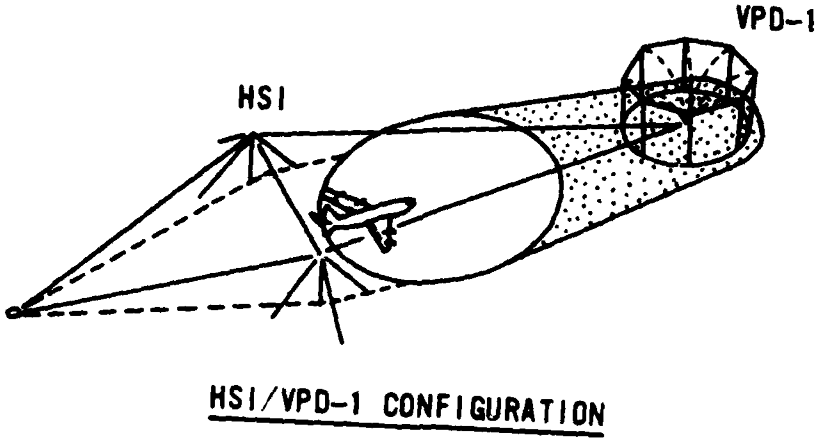


Figure 14. HSI/VPD-1 configuration.

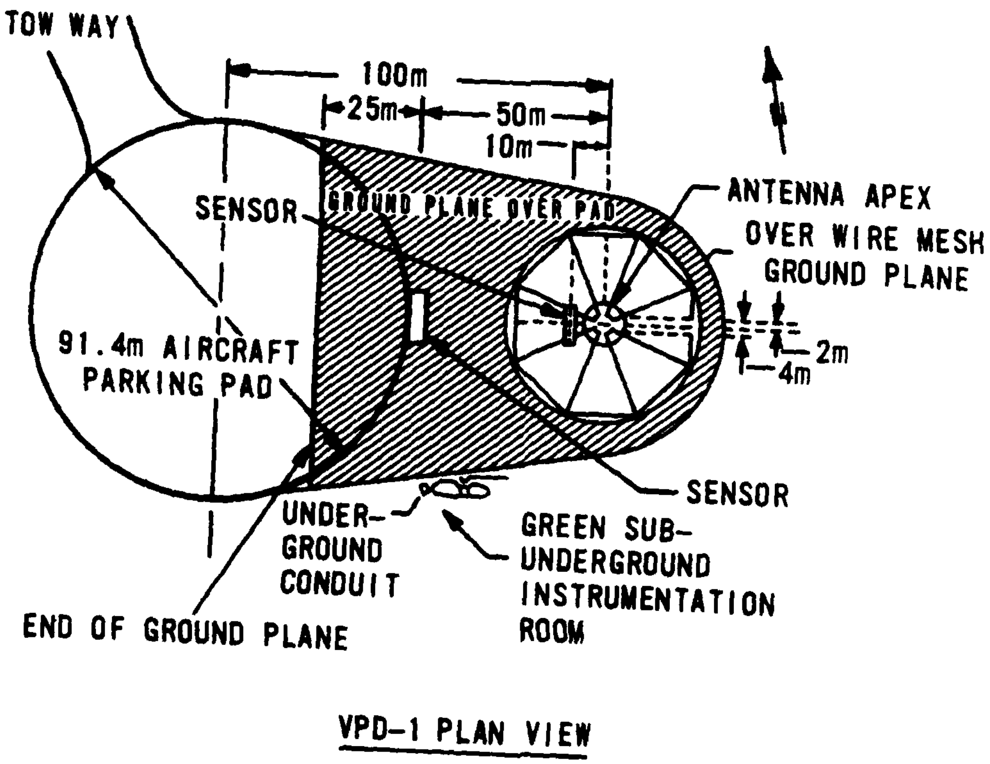


Figure 15. VPD-1 plan view.

services the explosive weapons loading area. Towing of the EMPTAC from the TRESTLE hardstand to VPD-I will require advanced planning/coordination, but should present no major problems.

2.3.3 Pulse Environment

The VPD-I pulser is much less powerful than the VPD-II pulser. It also produces a vertical E-field which varies with distance from the source (R) as I/R. It is capable of producing a field level of 4 kV/m at 100 m. The pulse has a rise time of approximately 4 ns and the antenna current decay time is approximately 25 ns.

3.0 POLICIES AND PROCEDURES

3.1 GENERAL

This section provides basic AFWL policy, guidelines, and information to potential users of AFWL's EMP test aircraft so that they can properly plan and coordinate programs and projects using the EMP test aircraft. The term "user" refers to the organization or agency that bears overall responsibility for planning, programming, coordinating and funding the tests to be conducted with AFWL's EMPTAC. Figure 16 details the overall EMP test program flow, required documentation or planning actions, and periods when actions or documentation are needed. This program flow is used as a guide for this section in discussing the policies and guidelines from the initial test planning through test operations. The next section (Section 4) discusses documentation requirements with regard to purpose and content. A key factor in this overall EMP test program is that the AFWL's early involvement in any program/project is essential for effective long-range forecasting, scheduling, budgeting and testing. Recognizing that programs/projects differ, AFWL will consider certain coordination deviations from these basic guidelines to accommodate the user's needs.

3.2 PROGRAM INITIATION

AFWL provides support for those programs approved and assigned to its EMP test facilities. This subsection summarizes the procedures required to obtain test program support; i.e., how the user can introduce his program to AFWL, state his requirements for support, and obtain support as requested. Figure 16 shows how this process works, what is required, and when it is required. Each of the items in Fig. 16 is briefly discussed in this section.

3.2.1 Importance of a Timely Liaison

Because of the large number of requests (and the variety of programmed projects) that are brought to AFWL, joint (user/AFWL) advance planning information in sufficient detail is needed to assure that AFWL's facilities and

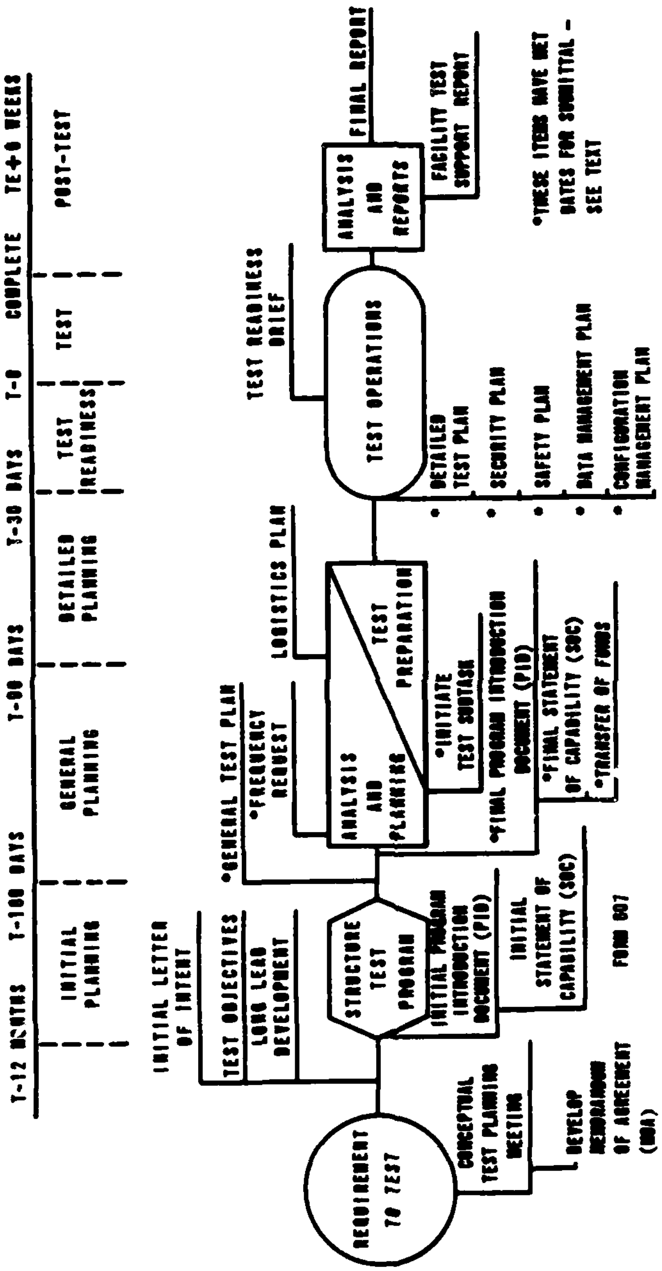


Figure 16. Overall EMP test plan.

support are adequate to meet the user's requirements. Since EMP testing entails the operation of numerous support systems, proper planning requires a technical exchange as soon as possible after the user's testing needs are known. This interchange, if conducted early, can be mutually beneficial to both the user and to AFWL.

Early initial contact with AFWL for planning should be directed to AFWL's Aircraft and Missiles Division, Nuclear Technology Office (AFWL/NTA). A program support focal point will then be assigned to the project. Use of the EMPTAC should then be coordinated through the Systems Section, Applications Branch (AFWL/NTAAA).

3.2.2 Conceptual Test Planning Meeting

Early test planning can better ensure the success of any given test program. An initial conceptual test planning meeting should take place as soon as a requirement to use EMPTAC is identified and, if possible, at least a year before any planned test start date. Conceptual test planning meetings provide the best means of establishing feasibility of testing, preliminary estimates of equipment and hardware requirements, and delineating requirements and responsibilities for future actions. Potential users are encouraged to request and participate in these meetings at AFWL before initiating the formal documentation cycle. A typical agenda for such a meeting is:

- EMPTAC/Facility orientation and tour
- User outlines general requirements - outlines test objectives
- Conceptual planning discussion - methodology/resources/schedules/capabilities
- Brief user on precedures and documentation
- Provide support as required on drafting Program Introduction Document (PID)
- Open cross talk or discussion

To schedule a meeting, contact AFWL/NTA.

3.2.3 Program Introduction

The program support focal point will receive, staff, and process all formal requests for AFWL conduct or support of EMP testing programs and projects. This includes the responsibility for coordinating and documenting AFWL support and assisting or advising the customer on how to obtain authorized support. A potential user of the EMPTAC will submit all formal requests to the support focal point for staffing and processing.

3.2.4 Memorandum of Agreement (MOA)

A memorandum of agreement is required for the EMPTAC Program. This is necessary because of the scope (size) of its test program and diverse organizational interactions (e.g., inter Department of Defense). The need for an MOA, program introduction document (PID), or statement of capability (SOC) must be determined as soon as the requirement to test has been identified. For tests which are small in scope and organizational interactions, the PID and SOC can be used to document the division of organizational responsibilities, rather than the formal MOA.

3.3 COST AND SCHEDULING

The user must notify AFWL of firm test requirements early enough to allow facility scheduling, cost estimating, programming, and contracting for operation and maintenance requirements. This should be done at the conceptual test meetings, if possible. Reimbursable costs will be formalized using the applicable funding documents. Costs are very sensitive to changing user requirements. Accordingly, AFWL should be immediately advised of any changes which will affect the nature, timing, or scope of the support expected. As noted in Section 3.3.1, AFWL will provide a written SOC and AFSC Form 607 (Budget Estimate) in response to a user's PID submittal.

3.3.1 Simulator Scheduling

A master schedule for all of AFWL's EMP test facilities is constantly maintained and updated. Organizations that plan to use the facilities should

tentatively reserve the facilities as early as possible by contacting the focal point. The first formal scheduling step is to submit an initial letter of intent at or before the first conceptual test planning meeting. A user's planned test is then added to the AFWL EMP facilities integrated test planning schedule. This tentative reservation must be made at least 12 to 18 mo in advance of the fiscal year of the test to allow resolution of potential schedule conflicts and to enable the user to plan budgetary submissions with sufficient lead time. In conjunction with this scheduling action, the user should identify test objectives and long-lead development items needed to support the tests. The next step in firming up the test schedule and anticipated AFWL support is to submit an initial PID. This should be done no later than 12 mo prior to the planned test start date. A PID will be accepted no later than 6 mo prior to the planned test start date to allow for unforeseen difficulties. Within 30 days of receipt of the PID, AFWL will respond with an initial SOC and an AFSC Form 607 with estimated funding by fiscal year required from the user to support the test program.

3.3.2 Schedule Changes

AFWL will accommodate schedule changes to the extent that simulators are not otherwise committed to other programs. If a test is cancelled, the user organization will be required to reimburse only the test-related costs already incurred by AFWL (see 3.3.5.7).

3.3.3 Resolving Schedule Conflicts

When schedule conflicts occur between programs with like priorities, AFWL will advise affected users and suggest changes that attempt to satisfy the users' needs. Then AFWL will discuss possible solutions with the users and, if resolution cannot be reached, the alternatives and the contending user organizations' positions will be referred to higher authority (depending on the user's parent organization) for resolution. If a user is required to reschedule due to conflicts with a higher priority effort, AFWL will notify the user immediately. Primary responsibility to obtain resolution, through coordination with AFWL and all interested agencies and offices, will be borne by the user.

3.3.4 Test Working Hours

The AFWL facilities are normally operational from 0730 to 1630, Monday through Friday of each week, excluding legal holidays. Tests will normally be restricted to normal working hours. Operations may be scheduled outside of the normal operating day when urgency and test dictates; however, only when overtime is specifically authorized and funded.

3.3.5 Reimbursement

There are numerous regulations and directives governing reimbursement requirements. These directives establish policies and funding practices that apply to different agencies and organizations; e.g., Air Force, Air Force Systems Command (AFSC), DOD, non-DOD, etc. The appropriate funding documentation and reimbursement procedures will be determined for each test early in the planning phase. Regardless of the procedures used, users must plan, program, and pay for all applicable AFWL support costs.

AFSC Regulation 172-2, "Funding Support and Use of R&D Activities," establishes the basic funding and reimbursement policies used by AFWL. The provisions of AFSCR 172-2 are directives to AFSC organizations, and, in addition, they establish the guidelines that AFWL follows when supporting the tests of any organization. AFSCR 172-8, "Budgeting and Funding for Test and Evaluation," is another regulation that AFWL uses for general reference and guidance to manage test support costs. One of the main variations from these AFSCR guidelines is time responses for submitting test requirements and funding. For example, AFWL has been able to provide support in a much shorter period of time than specified in the AFSCR guidelines. Therefore, the AFWL time milestones are primarily based on contract support and test preparation needs. The cost information listed in Table 1 was extracted from the above regulations to give potential customers some detail and insight on reimbursable costs.

TABLE 1. Reimbursable costs.

Cost Category	AFSC/USAF	Other DOD	Non-DOD Fed	Non-Fed
Direct Labor (Military)	No	No	Yes	Yes
Direct Labor (Civilian)	Yes	Yes	Yes	Yes
Other Direct Costs	Yes	Yes	Yes	Yes
Indirect/Overhead (Mil)	No	No	Yes	Yes
Indirect/Overhead (Civ)	No	Yes	Yes	Yes
User Charges	No	No	No	No

3.3.5.1 Direct Labor. Direct Test and Evaluation support costs and other additional direct costs will be reimbursed. These costs will be programmed and budgeted for in the mission program funds (AFSCR 172-2 and 172-8).

3.3.5.2 Other Direct Costs. These include travel, equipment, supply, Operations & Maintenance contractor support, machine shop, technical photographic support, technical information center charges (including STINFO and graphics), computer time, etc., (AFSCR 172-8).

3.3.5.3 Common (Indirect) Support. Common support (overhead) provided to Air Force users is not reimbursable. Common support provided to non-Air Force users will be reimbursed. Common support costs are programmed and budgeted for in the AFWL institutional funds (AFSCR 172-2 and 172-8).

3.3.5.4 User Charges. These cover amortization and depreciation of government-owned facilities used to support a nonfederal organization (AFSCR 172-8).

3.3.5.5 EMPTAC Modification and Restoration. When modification of the EMPTAC is required to accommodate a user's tests, the cost of modifying the EMPTAC and restoring it to the original configuration will be included in the direct support mission project funds estimate. Depending on the type of modification, the aircraft may not require complete restoration.

3.3.5.6 Equipment. If AFWL purchases equipment, the equipment must be purchased with one fund source. The equipment belongs to the organization providing the funds. After AFWL is through with the equipment, the user provides them with disposition instructions. Equipment procured with user funds for use during EMP testing at an AFWL facility will remain at the facility site unless the equipment is unique to the mission project or it is needed for later testing at another site (AFSCR 172-2).

3.3.5.7 Delays, Termination and Rescheduling. After acceptance of the project order (funding document), direct costs incurred by AFWL which are associated with user-caused schedule changes, aborts, and cancellations are chargeable to the user and will be reimbursed. The requirements in AFSCR 172-8 for funding reimbursement for rescheduled AFSC users due to preemption by higher priority efforts, will be applied as general guidelines for non-AFSC users as well.

3.3.5.8 Accounting System. The Job Order Cost Accounting System (JOCAS) will be used to account for actual expenses of test support. Accounting information other than that available through JOCAS will not be provided to the user unless those provisions are part of the PID, SOC, or MOA and the user agrees to reimburse AFWL for the additional accounting support..

3.3.5.9 Accrued Costs. The facilities will monitor accrued costs of work performed. If excess funds exist or if additional funds are required, the user organization will be notified not later than 45 days prior to the expiration of the funding provided.

Since costs are extremely sensitive to changes, it is imperative that planning and budgeting between AFWL and its users be a continuum with each having an obligation to work together and keep each other informed of any changes. Should unanticipated expenses to encountered, the user will be promptly advised so that action can be initiated for additional funding, reduction in the scope of testing, or both.

3.4 COORDINATION DATE REQUIREMENTS

Table 2 summarizes the early coordination activities discussed in this section and lists their latest submission dates. As previously stated, early coordination between the user and AFWL is very desirable, and so submission before those dates is strongly encouraged.

TABLE 2. Important early coordination probes.

	Coordination Activity	Target Date (months prior to test start)
1.	Initial contact with AFWL	As soon as possible
2.	Tentative scheduling of test at AFWL facilities	12-18 (before FY of test)
3.	Conceptual test planning meeting	12
4.	Initial program introduction document	12

4.0 DOCUMENTATION REQUIREMENTS

All prospective users who desire to use AFWL services or facilities must submit their initial requirements via a Program Introduction Document. There is no specific format but all users should contact AFWL/NTAA for information on typical formats. The remainder of this section describes the documentation required for use of the EMPTAC.

4.1 PROGRAM INTRODUCTION DOCUMENT

The submission of the PID is normally the user's first official action in obtaining AFWL support for his program. It is a scope-setting document which remains in existence for the life of the program. The PID describes the program, states the objectives, identifies significant milestones/lead times. The PID must cover the entire test period even if multiple fiscal years are involved. It is important that the user submit the PID as early as possible for planning purposes even though the program may not be officially funded. The PID should be submitted no later than 12 mo prior to the planned test date.

4.2 STATEMENT OF CAPABILITY

The SOC is prepared by AFWL in response to the user's PID. It provides a definite statement of the support the user can expect and outlines capabilities and resources that AFWL must acquire in order to satisfy the program requirements. It delineates responsibilities between AFWL and the user, including the provisions of resources, and lists the support restraints resulting from AFWL's inability to meet the program's requirements. The SOC will usually be sent to the user within 30 days after receiving the PID.

AFWL has established and maintains various EMP testing capabilities; including both facility and computer software configuration control and standardized operating, calibration, checking, and testing procedures. As a general rule, the user plans to use existing facilities, capabilities and procedures without change. However, there are times when existing facilities

and capabilities are not enough, and different and/or additional capabilities are required. In these cases, the user should provide AFWL with sufficient lead-time and funds for obtaining the additional equipment and for making the required changes. Such requirements should be discussed with AFWL: (a) during the user's initial contact with AFWL, (b) during tentative test scheduling meetings, and (c) during the conceptual test planning meetings. They should be formally identified in the initial PID submitted to AFWL. Remember, changes from the normal (existing) facilities and testing capabilities require increased lead-time to investigate possible trade-offs and to accomplish testing in a timely manner.

4.3 FUNDING DOCUMENTS

Funding documentation requirements vary depending on the user's organization (i.e., Air Force, Air Force Systems Command, DOD, Non-DOD, etc.). Specific and appropriate requirements will be determined early in the test planning phase. For convenience, all documents such as a Project Order (AF Form 185), Military Interdepartmental Purchase Request (MIPR), etc., will be referred to as the funding documents.

4.3.1 AFSC Form 607, Budget Estimate Agreement

The AFSC Form 607 is AFWL's cost estimate of the user's test program. It is used for budget planning. This form will be prepared by AFWL based on the data developed for the SOC. For the initial test effort, the original AFSC Form 607 will be forwarded to the user as an attachment to the SOC. Then, if the cost and schedule estimates are acceptable, the forms will be signed, the original returned to AFWL, and a copy retained by the user. The initial AFSC Form 607 will cover the first fiscal year of testing and forecast for the second year, if appropriate. For test efforts conducted in more than 1 fiscal year, the AFSC Form 607 (for the second and subsequent fiscal years) will be developed annually through negotiations between AFWL and user. These forms are for planning and budgeting for the applicable fiscal year only and will support the reimbursable portion of the user's program/project budget submissions.

4.3.2 Funding Documents

The user's program/project office issues the necessary funding documents to AFWL at the beginning of each fiscal year. Amounts issued by the funding project orders must be consistent with the previously negotiated AFSC Form 607. However, they may be more or less than the negotiated amounts, depending on the most current program funding changes (amendments to the original funding documents) and revised test support requirements. The originating AFSC Form 607 should be as complete and accurate as possible; piece-meal funding during the year through amendments to a funding document is discouraged.

There are two basic types of test support costs. One type is the planning support costs which involve travel, special studies, civilian salaries, and long-lead items. These costs should be funded by the user at the beginning of each fiscal year. The second type of funding is support for fielding the tests. The user must fund AFWL's test-related direct costs. These funds must be transferred to AFWL no later than 5 mo prior to the planned test start date. Any delay in receiving these funds will impact the test O&M subtask turn on (4 mo prior to the test), and thus, AFWL support to the user. Acceptance of funding documents constitutes a contract between the user and AFWL.

Changes to test requirements after acceptance of a funding document will be negotiated. If a project is cancelled, AFWL will be reimbursed for costs incurred after accepting the funding document, including preparation for all of the tests. AFWL will also be reimbursed for all of the direct costs of the user-caused aborts or test rescheduling.

4.4 TEST OPERATIONS AND MAINTENANCE SUBTASKS

Contractors operate and maintain the EMP test aircraft and AFWL's EMP simulation facilities. These are separate contracts, each requiring subtasks (miniature contracts) for conducting the proposed efforts. To prepare for and support a test, AFWL must write a complete subtask package for each

effort required. Each subtask must be negotiated and contractually let before work can be officially started. This also applies for each facility's O&M subtask. The entire process takes from 1 to 2 mo. Under the present operating procedures, the EMP simulation facilities are maintained so that they can be activated for a test within 4 mo. Therefore, if the EMP simulation facilities are to be used, the test O&M subtask must also be started 4 mo prior to a test.

4.5 STANDARD TEST PLAN REQUIREMENTS

Comprehensive, technically sound, and clearly written test plans are essential to the proper planning and execution of any test. The following test plans are required submissions from users before any EMP testing will be allowed on the EMPTAC.

4.5.1 General Test Plan

The general test plan (GTP) sets the scope of and defines the overall test effort. The GTP should compliment the PID; defining the overall test requirements and objectives listed in the PID. It is also a key document in defining the operation and maintenance support that will be required. The GTP must be submitted to the EMPTAC test manager at least 9 mo prior to the planned test start date. The GTP content requirements are defined in greater detail in AFWL's detailed planning guides.

4.5.2 Detailed Test Plan

The detailed test plan (DTP) is the implementing document for the GTP. The DTP must be submitted to the EMPTAC test manager no later than 30 days prior to the planned test start date. The importance of the DTP must be understood. It is the final and most detailed defining standard for the test. It is the basis for AFWL's allocation of resources to the user. Detailed content requirements for the DTP can be found in AFWL's detailed planning guides.

4.5.3 Safety Plan

This plan must be developed, submitted to AFWL not later than 60 days prior to the test, briefed through the AFWL Technical Safety Committee, and approved before the test can start. It covers test, test object, and test facility safety. Safety briefings to all participants are also required.

4.5.4 Security Plan

This plan must be provided to cover all security aspects of the test. This plan must be submitted to AFWL not later than 60 days prior to testing.

4.6 OTHER PLANS

Other plans that are always desired and sometimes required to be developed to support a test because of required AFWL support or nonstandard procedures described in the following subsections.

4.6.1 Logistics Plan

This plan should be completed at least 4 mo prior to the test. It should cover all test-related logistics for the test object and its support through special test equipment.

4.6.2 Data Management Plan

This plan should be prepared to establish test point priorities, quality control guidelines, data processing guidelines, and data control procedures. It should be submitted to AFWL 60 days prior to the test. It is preferred that the user provide his own person for quality control.

4.6.3 Aircraft Modification Plan

One of the major headaches with a complex test object like an airplane is knowing and maintaining the test configuration. Configuration control is a

key tool to working this problem. One should have a plan which details how this control will be maintained; how equipment taken on or off the aircraft will be controlled; and how possible box failures will be tracked and reported. This plan should be submitted to AFWL 30 days prior to the test.

4.7 RADIO FREQUENCY ASSIGNMENTS

Requirements for assignment radio frequencies in support of a test should be identified by the user as early as possible in the documentation cycle, i.e., in the PID. It is the user's responsibility to ensure that the proper documentation is submitted through channels to the Joint Frequency Panel of the Military Communications - Electronics Board for approval of any equipment used during a test at AFWL. Air Force users should consult AFR 100-31, Frequency Management and Electromagnetic Compatibility for the frequency allocation procedures. Other users should refer to the applicable service directive or DOD Directive 4650.1, Management and Use of the Radio Frequency Spectrum. The basic time guideline is that the request for frequency allocation must be submitted at least 6 mo prior to test start.

4.8 TEST READINESS BRIEFINGS

After all test planning and preparation efforts have been completed, there remains one more step before starting the test. This is a briefing to designated higher level management personnel to demonstrate that everything is ready for the test to begin. This briefing should be mainly a test logistics and support briefing, not a technical briefing. Key items will be safety, security, test object status and test facility and support status. This briefing will be given not later than 5 working days prior to the test.

4.9 DOCUMENTATION SUBMITTAL DATE REQUIREMENTS SUMMARY

Table 3 summarizes the submittal date requirements for the documentation discussed in Sections 4.1 through 4.8. It should be noted that the dates given are the latest possible dates for submission without impact on test scheduling. Earlier submissions are highly advised. A second point to keep

in mind is that these are submittal dates. Initial planning to meet the documentation requirements should begin as soon as possible to insure that long-lead time items and services can be obtained in time to define required plans and support the test preparation or test conduct.

TABLE 3. Documentation submittal dates requirements summary.

User-prepared Documents	Latest Date to AFWL (months prior to test)	AFWL-generated Documents	Date to User (months)
Initial PID	12	Initial SOC	IPID + 1
Final PID	8	Final SOC	FPID + 1
General Test Plan (GTP)	8	Budget Estimate (AFSC Form 607)	With SOC
Funding (MIPRs, POs)	3		
Detailed Test Plan (DTP)	2	Test Subtask	4
Safety Plan	2		
Security Plan	2		
Logistics Plan [a]	3		
Modification Plan [a]	2		
Data Management Plan [a]	2		

[a] Needed only if activities covered by the plan require AFWL support or a change in standard procedures.

REFERENCES

1. AFWL EMP Test Facilities User's Planning Guide, AFWL-NTM-TN-81-01, Air Force Weapons Laboratory, Kirtland Air Force Base, NM 87117-6008, September 1982.

2. Keck, H., EMPTAC Experiment Configuration Modification (#1) Final Report, 44717-A070-UT-00, TRW Defense Systems Group, Albuquerque, NM 87106, 31 March 1986.

3. Miller, P., Shielded Cable Tester Proof-of-Concept Report, TRW Defense Systems Group, Albuquerque, NM 87106, June 1986.

4. Stohler, R.I.; Dombroski, E.; and Martinez, J.; Users Manual for the EMPTAC LeCroy Data Processing System, DC-FR-4088350-1, Dikewood, Division of Kaman Sciences Corp, Albuquerque, NM 87102, July 1986.

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